March 1987

DCIEM No. 87-RR-09

EXPRES Fitness Tests as Predictors of Stretcher Carrying Ability.

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ABSTRACT

The purpose of the present study was to determine if a predictive relationship exists between the standard physical tests annually administered to all CF personnel (CF EXPRES tests) and the performance of the common military task of stretcher carrying over land. Nine healthy male (mean age 31) and 9 healthy female (mean age 26) subjects performed a handgrip strength test, push-ups, sit-ups, a submaximal aerobic fitness test and a stretcher carrying task. The data show that the single best predictor of task performance for females was the indirect measure of maximum aerobic power ($\dot{V}O_2max$) ($p<.05$) while no significant single predictor was found for males. For females, $\dot{V}O_2max$, hand grip strength and weight were combined to form a significant multiple regression equation which accounted for 74% for the variance in stretcher carrying performance. No significant predictive regression equations were found for males. It is concluded that: 1) the EXPRES tests have limited predictive power for performance of the stretcher carrying task for females, and no predictive power for males; and 2) for each of the sexes, individual EXPRES tests have different predictive powers.

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INTRODUCTION

The development of effective selection standards which accurately evaluate a person's physical capabilities to perform a job should be an important goal of all organizations. The high costs of training a person to perform a particular job are wasted if, after training, it is found that that person lacks the required physical ability to meet performance standards. With an organization the size of the Canadian Forces (CF), the development of effective physical selection standards becomes critical.

In developing selection standards, a common approach is to develop a test that is an accurate predictor of a person's physical performance of an actual task (1). Previous research has shown that reliable and valid predictors can best be obtained when the predictive test closely resembles the actual task (2). Therefore, if a particular job encompasses a variety of tasks, a series of screening tests would be required. This approach is not feasible given the enormous diversity of occupations within the CF.

An alternative to using a single predictive test for each task is to develop a series of physical tests that would yield a more general indication of whole body capability, and which would have acceptable predictive power for many tasks. Currently, the CF uses a series of physical fitness tests, Exercise Prescription (EXPRES), to evaluate the fitness levels of CF personnel on an annual basis (3). Performance criteria are currently being established for each of these fitness tests which relate to the acceptable performance of seven common tasks (4,5). The common tasks have been defined by the Directorate of Physical Education and Recreation Amenities (DPERA) in conjunction with other National Defence Headquarters directorates, as tasks which all personnel, even those in otherwise sedentary jobs, must be able to perform. Determination of any predictive relationships which may exist between the EXPRES test battery and the common tasks may have important implications for the development of the minimum standards for physical fitness. One of the most physically demanding of these common tasks is casualty evacuation by stretcher over land. The purpose of this study was to evaluate the strength of

the relationship between the EXPRES tests and the performance of the common military task of stretcher carrying over land.

METHODS

Subjects were nine healthy males and nine healthy females. All subjects performed all fitness tests according to the CF EXPRES protocol (3), and the stretcher carrying task.

EXPRES Tests

Height and weight were measured according to standard procedures, using Detecto-Medic ™ scales and height bar. The fitness tests were conducted in the order listed below, with a 20 minute rest between the sit-ups and push-ups and a 30 minute rest before the aerobic fitness test.

Arm Strength - Handgrip Strength

Handgrip strength was measured using a handgrip dynamometer (Owl Biomedical Inc). Strength of each hand was tested with the subject standing erect and arms hanging vertically. Grip strength in each hand was tested three times, with the maximum value of the three being recorded. The subject began the next trial when he she felt sufficiently rested. The data from the hand which yielded the greater value is referred to as strong grip, and the data from the other hand is referred to as weak grip. Total grip is the sum of the data from the two hands.

Abdominal Strength - Sit-ups

Each subject was asked to perform as many bent-knee sit-ups as possible in 60 seconds, with the tester securing the subject's feet.

Upper Body Strength - Push-ups

Each subject was asked to perform as many continuous push-ups as possible. The subjects were instructed that they were not under any time constraints but that any rest pauses would signal the end of the test. Males performed standard push-ups and females performed push-ups using the knees as the pivot point.

Aerobic Work Capacity - Canadian Aerobic Fitness Test (CAFT)

The CAFT is a submaximal, progressive step test used to predict maximum oxygen uptake ($\dot{V}O_2max$). The subject is allowed to continue to a higher intensity only if their heart rate is below a threshold value. Heart rate was constantly monitored using a Cambridge VS4 Electrocardiograph.

Stretcher Carrying Task

The task required the subjects to carry an 80 kg load on a stretcher a distance of 500m, as quickly as possible without running. Rest pauses were allowed if necessary, the frequency and duration of which were left to the discretion of the subjects. The load was intended to represent the weight of a clothed casualty and consisted of sandbags placed on a standard military stretcher.

A support frame was constructed and attached to the stretcher, such that the stretcher handles were located one metre from the floor (Figure 1). This structure was added for reasons of safety, particularly during lifting and lowering the load. The stretcher carry was performed on an oval, indoor 68 m track on a level, flat concrete surface.

To allow the subject to set the walking pace, he she carried the front end of the stretcher. An experienced and fit member of the investigating team assumed the position at the back of the stretcher and did not dictate or limit the pace of the test subject. Two other members of the investigating team accompanied the stretcher bearers, always remaining behind the test subject; one recorded the data and the other ensured the

safety of the subject.

Heart rate was recorded every 10 seconds using a portable data recorder (PMS-8, manufactured by the Vitalog Corporation, Palo Alto, California).

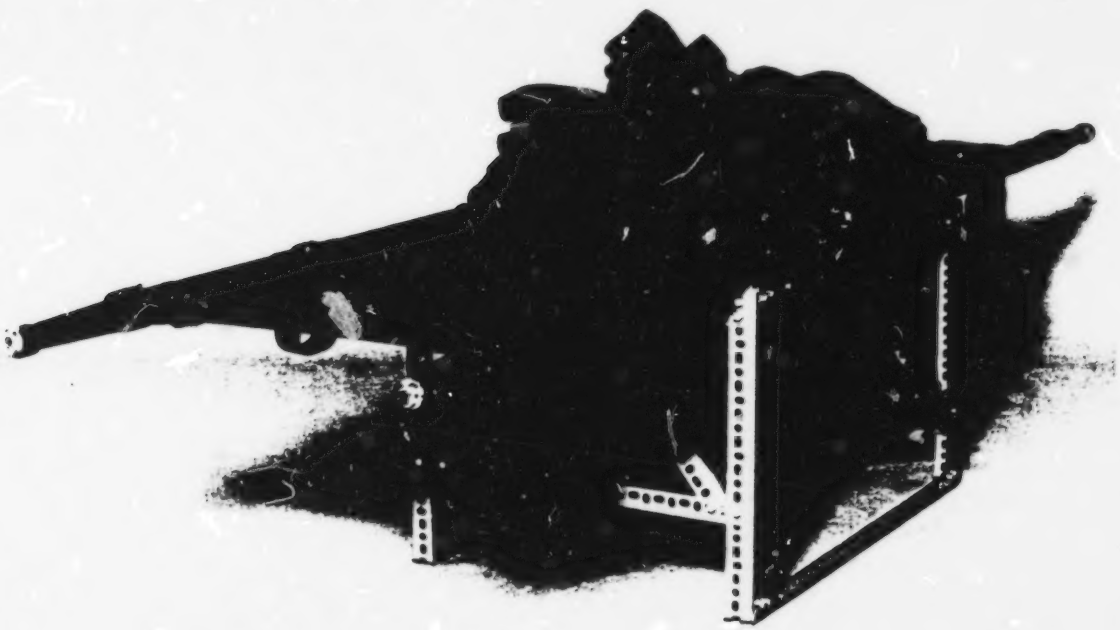

Figure 1. Stretcher used showing support frame and load.

RESULTS

Table 1. Summary of Performance Data				
Variable	Females		Males	
	Mean	Standard Deviation	Mean	Standard Deviation
height (cm)	165.0	6.96	178.1	5.65
weight (kg)	57.9	7.26	79.5	7.55
age (years)	26.0	4.53	31.0	9.25
strong grip (kg)	37.3	6.36	56.9	6.01
weak grip (kg)	33.6	4.33	54.1	5.47
total grip (kg)	70.9	10.19	111.0	11.23
push ups	31.1	9.80	33.8	18.23
sit ups	45.1	5.97	40.2	10.64
$\dot{V}O_2$max (ml/kg/min)	38.2	2.80	50.5	5.78
$\dot{V}O_2$max (l/min)	2.2	.16	4.0	.46

Table 1 presents the performance data for all subjects for all the EXPRES tests. Comparison of these performance data with published Canadian norms (6) indicates that the subjects in this study were above the 80th percentile in all the performance tests. Comparison of the data with Canadian Forces performance data (7,8) indicates that the subjects were slightly above the 50th percentile of CF personnel.

Table 2. Summary of Correlation and Regression Analysis			
Predictor Test Variable	Simple Correlations		Regression Equations
	female n=9	male n=9	
1) height (cm)	-.551	-.144	
2) weight (kg)	-.311	-.436	Females
3) strong grip (kg)	-.525	-.263	2419 - 48.15(8) - 11.18(4) + 5.38(2)
4) weak grip (kg)	-.604	-.155	$R^2 = .744^*$ $p < .05$
5) total grip (kg)	-.585	-.216	
6) push ups	-.221	-.522	Males
7) sit ups	-.137	-.502	670 - 1.01(6) - 2.02(7) - 3.05(2)
8) $\dot{V}O_2$max (ml/kg/min)	-.832*	-.411	$R^2 = .542$ p=NS (.23)
9) $\dot{V}O_2$max (l/min)	-.577	-.571	

* $p < .05$

Table 2 contains the simple Pearson correlation coefficients and the derived regression equations found between all test battery items and the stretcher carrying task. $\dot{V}O_2$max had the only significant single correlation with task performance for the females and no significant correlations were found for males.

The stepwise, optimal regression analysis, although based on relatively small sample sizes, was conducted to determine which test items combined to yield the highest multiple correlations. The three EXPRES tests combining to yield the regression equation with the highest coefficient of determination (R^2) for each sex are listed below.

1) females: $\dot{V}O_2max$, weak grip and weight;

2) males: push-ups, sit-ups and weight.

DISCUSSION

The results of the correlation and regression analysis presented in Table 2 indicate that for females, the EXPRES tests are marginally useful in predicting performance of the stretcher carrying task. $\dot{V}O_2max$ was found to be the best single predictor of task performance and combined with weak grip and weight to form a significant predictive equation which could account for 74% of the variance noted in the stretcher carrying task. For males, the EXPRES tests, either singly or in combination, are not useful in predicting performance of the stretcher carrying task.

This lack of a predictive power of the tests for males may be attributed to two factors. First, the results may reflect the difference between the level of physical exertion required to perform the EXPRES tests and that required for the task. Each of the EXPRES tests requires the subject to exert maximally; for example, to perform as many sit-ups as possible within one minute, to perform as many push-ups as possible and, for the hand grip test, to exert a maximal force on the hand dynamometer. In these tests, no constraints were imposed on the performance objectives. In contrast, although the subjects were asked for a maximal effort on the stretcher carrying task, they were limited to *walking* as quickly as possible to cover the 500m. However, since the weight of the stretcher represented a higher percentage of body weight for the females, they were working at a workload closer to their maximum physical effort. Therefore, the maximal

EXPRES tests were more useful in predicting female task performance. It is suggested that for males, the lack of a predictive relationship may be the result of the EXPRES test demanding a maximum physical exertion while the task demanded a physical effort substantially below their maximum.

The second factor potentially contributing to the lack of a predictive relationship for males is the difference between the fitness components which the EXPRES tests are designed to evaluate and those required to perform the task. In order to achieve good prediction, a group of tests which accurately reflect the task demands is required. All the subjects indicated that the forces required from the forearm muscles were the most physically demanding aspects of the task. The EXPRES protocol includes measures of upper body endurance (push-ups) and forearm strength (hardgrip), but does not include a measure of forearm muscular endurance. The predictive power of the test could be increased if a test of forearm muscular endurance was included.

The results of the regression analysis also showed that the predictors found for males differed from those found for females. If these predictors are valid indicators of the most stressed physical components, then the finding that $\dot{V}O_2max$ was the best predictor for females is logical since they were working at a higher relative workload. Likewise, the finding that the weak grip score was the second best predictor for females indicates that forearm strength was also highly stressed. However, for males, it is suggested that the physical components are not stressed to the same extent since no significant predictors were found.

In summary, the predictive relationships between the EXPRES tests and the stretcher carrying task indicate that different tests may have to be administered to each sex in order to predict performance on a specific task. These tests will vary with the performance objectives of a given task and the gender differences in the physical components required to perform the task. It is noted that the current purpose of the EXPRES tests is to assess physical fitness. Therefore, their use as performance predictors on a given

task may be limited.

CONCLUSIONS

It is concluded that the EXPRES tests have limited predictive power for the stretcher carrying task for both males and females. The tests that appeared to be most useful were those which measured a physical component that was maximally stressed in the task.

It is concluded that the predictive power of the individual EXPRES tests for performance of the stretcher carrying task differs for each of the sexes. This indicates that different tests may have to be administered to each sex in order to predict performance on any given task.

In addition, it is concluded that further research is needed, utilizing more subjects and other military tasks, to determine the efficacy of using EXPRES tests as predictors of military performance.

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